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ABSTRACT

In 1974, as part of a reciprocal agreement between Canada and the Federal Republic of Germany, a delegation of Canadian experts visited Germany to examine programs in Computer Assisted Instruction (CAI) and to explore areas of future cooperation. The delegation examined CAI program support and administrative structures in German education. Special attention was given to a center for research and development in teaching technology, a CAI development unit at a university, and a secondary school program using CAI. Areas of possible cooperation identified during the visit included exchanges of papers, computer programs, and guest workers. (EMH)

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National Research Council, Canada

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Associate Committee on Instructional Technology

Computer-aided Learning in The Federal Republic of Germany

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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A Report Prepared in Cooperation with

The Educational Technology Program

Department of Communications

13-23 October 1974

NRC 14946

Ce rapport est aussi disponible en français sur demande

Canadian CAL Delegation to the Federal Republic of Germany

13-23 October 1974

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J.W. Brahan	National Research Council
J. Hart	University of Western Ontario
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ACKNOWLEDGMENT

The members of the delegation wish to thank the German Federal Ministry for Research and Technology and the project members of the institutions visited for their hospitality and the time which they so willingly devoted to the discussions. The delegation was particularly grateful for the most valuable assistance of Herr Lindner, who accompanied the group throughout the visit.

The delegation gratefully acknowledges the support of the Educational Technology Branch of the Department of Communications, the National Research Council of Canada and the Associate Committee on Instructional Technology.

Introduction

In 1973, under the general terms of a Scientific and Technical Cooperation agreement which exists between Canada and West Germany, a delegation of German experts in Computer-Aided Learning (CAL) visited Canada. The objectives of the visit included making a preliminary assessment of the possibilities of cooperation between the two countries in the field of CAL. The delegation visited seven Canadian CAL centres and held discussions with representatives from three other centres. The visit resulted in a fruitful exchange of information and the establishment of useful individual contacts. The German delegation recommended that a reciprocal visit by a Canadian delegation should take place in order to better define areas of cooperation and to promote contacts between CAL centres.

With the cooperation of the Educational Technology Branch of the Department of Communications, and the Ministry of State for Science and Technology, the NRC Associate Committee on Instructional Technology organized a visit of a Canadian CAL delegation to Germany in October 1974. The delegation, which was led by Dr. Herbert J. Hallworth of the University of Calgary, visited six centres following an itinerary suggested by the German Government. Each of these centres has a major project underway which is funded under the Data Processing Support Program of the Federal Republic of Germany. In addition to the projects at these centres which are described in detail in this report, CAL work which has been, or is being funded under this program includes the

following: Institute of Technology, Aachen (computer language development and initially some hardware development); Nixdorf (production of a system called BAKKALAUREUS, which included slide projection and audio presentation but was limited to multiple-choice responses); Siemens (development of LIDIA, implementation of PLANIT, development of programs for test generation, development of a data bank system for use by school administrations); BTZ, Weisbaden (development of a specialized language to teach computer programming, a computer managed instruction project concerned with teaching mathematics to physics students); Friedrich-Wilhelm University of The Rhineland, Bonn (investigation of medical instruction using the computer); Justus Liebig University, Giessen (use of CAL to teach economics). In addition to these, a number of projects are underway related to the development of software for applications in the area of school administration. Detailed information and the names of contacts for specific projects can be obtained from Herr Lindner; Institut für Bildungsinformatik, Vorstand; Katenhaustr. 69-71; 4790 Paderborn, Postfach 467; West Germany.

The Data Processing Support Program

Major support is being provided for computer development and applications in the Federal Republic of Germany through a coordinated program which has been underway since 1967. This program is being carried out by the Federal Ministry for Research and Technology and involves cooperation with governments of the states (Länder), with industry, and with educational and research institutions. The Second

Data Processing Support Program which covers the period 1971-1975 has the following general objectives:

- increased and broader use of data processing in business and science;
- rationalization and increased efficiency of computer use in government internal administrative services and services to the public;
- development of basic computer capabilities in areas such as computer science, communications, engineering, etc.;
- creation of a well-balanced competitive situation for the German computer industry in European and world markets.

Within the current program, special emphasis is placed on education, particularly the education of data processing personnel. At the university level, research and development are promoted in the fundamentals of computer science as well as in the area of specific computer applications in various university departments. The integration of the computer in research and teaching is promoted by the provision of sufficient and easily accessible computer capacity.

The underlying objective of the promotion of research and development projects is to develop the capability necessary to successfully exploit the computer in both public and non-public fields. Specific areas receiving support are:

- computer-aided information, control and decision systems;
- computer applications in the field of education;
- data processing in medicine;
- computer-aided development and design;
- process control systems.

The program is also concerned with promoting the development of standard software packages and providing guidelines for the acquisition of computing equipment to ensure a reasonable degree of standardization. Another significant aspect of the program is the subsidization of industrial research in those areas which are considered vital to the competitiveness of computer companies.

Expenditures under the program for the period 1971-1973 have been approximately 966 million DM (368 million Dollars), broken down as follows:

Data processing applications	220×10^6 DM
University and training	184
Computer systems and technology	500
GMD (Institute for Mathematics and Date Processing)	62

A detailed summary of expenditures for the first and second data processing support programs can be found in Donth (1974).

Program Administration

The program is administered through "project carriers", institutions which are responsible for specific areas of the program. Each of these institutions has a demonstrated capability in the area for which it is responsible and has related in-house projects underway. For example, FEoLL (Research and Development Centre for Substantiated Teaching and Learning Methods) is the project carrier in the field of date processing applications in education.

Projects, which may be undertaken by industry, government departments, universities or other educational institutions, are discussed with the project carrier and a proposal is submitted to the ministry. Upon approval, funds allocated to the project are transferred to the project carrier which is responsible for the direct administration of the project, including technical review.

Project proposals may come to the project carrier from outside agencies, or they may be solicited by the project carrier. Through the program it is possible to support projects which are undertaken jointly, by industry and university, for example.

The use of institutions as project carriers, in which related work is underway, provides the necessary technical expertise to assess project proposals and avoids unnecessary proliferation of bureaucracy, but it can result in conflicts of interest when project proposals are submitted by the institution which is also the project carrier. To avoid such conflict, the project carrier function is operated as a separate unit in the institution and when proposals come from within, they are processed in the normal way. Upon approval of the project by the Ministry, however, funds are transferred directly to the institution, not to the project carrier. Thus the project carrier is not called upon to monitor projects within its own institution.

Computer Applications in Education

In Germany, education is the prerogative of the states or Länder. Responsibility for the promotion of scientific research and development

is within the area of responsibility of the federal government. An amendment to the constitution in 1969 permits the central government and state governments to cooperate in the planning of education.

As a result of this political structure, within the data processing program the central government's direct promotion of research and development related to education must be concerned with the technical aspects. Any implementation must be carried out by local governments but there can be cooperation with the central government if desired.

In the specific field of Computer-Aided Learning, the Federal Ministry for Research and Technology promotes research and development involving hardware, software and some courseware necessary to test the development systems. The Federal Ministry for Education and Science participates in the program and promotes cooperation between the federal government and the Länder to carry out CAL projects in model schools. It is the responsibility of the Länder, however, to make the decision regarding the introduction of CAL into the schools. It is to be noted that each of the six projects visited by the delegation was receiving support from both the central and the local governments.

Expenditure by the federal government on instructional applications of the computer under the Program amounted to 35 million DM (13 million Dollars) in the period 1971-1973. This can be divided into approximately 5 million for administrative and planning related applications and 30 million for Computer-Aided Learning.

The approach to CAL within the program seems to emphasize the application of the computer as an adjunct to the teacher. Comparatively

little attention is being given to main line instruction by means of the computer. Specific areas of CAL which were singled out as being of high importance are problem solving and simulation and gaming. The question of cost-effectiveness of CAL is considered important and is under study but it was felt that it is not possible to provide all of the answers to the cost-effectiveness question at the present time. Application areas of CAL have been confined to the formal school system and educational institutions. No industrial training projects have been undertaken as part of the program but it was noted that Lufthansa had, independently of the program, developed a CAL system utilizing its computer-based reservation system.

Gesellschaft für Mathematik und Datenverarbeitung mbH (GMD)
(Society for Mathematics and Data Processing Limited)

The GMD was formed in 1968 by the Federal Republic of Germany and the Land North-Rhine-Westphalia as a large scale research institution to carry out application-oriented basic research, applied research and development in the field of data processing. The GMD is divided into two main parts, the research institution and project-management departments.

The research institution is made up of ten institutes plus a computing centre with a budget for 1974 of 48 million DM. The institutes cover the following fields:

- planning and decision systems;
- mathematics;
- graphical data processing and structure recognition;

- computer and program structures;
- information systems research;
- software technology;
- teleprocessing;
- data processing and the law;
- information systems;
- education in informatics.

The computing centre of GMD operates equipment at three locations (Birlinghoven, Bonn and Darmstadt) and provides support to the research and training projects of GMD, and for computing requirements of the federal government and the Land North-Rhine-Westphalia.

The institutes undertake research and development work for government departments as well as working closely with universities and industry. In general, work which is undertaken for other government departments has a high multiplication effect in that the projects have a close relation to the on-going in-house research topics.

The project management side of GMD handles technical monitoring of data processing projects sponsored by the Federal Ministry of Research and Technology within industry, including evaluation of project proposals. Within the Second Data Processing Support Program, GMD is the project carrier for market-oriented research and development projects and future-oriented development projects. The 1974 budget for the project-management activity of GMD is approximately 180 million DM (68 million dollars). The organizational structure of the GMD is illustrated in Figure 1.

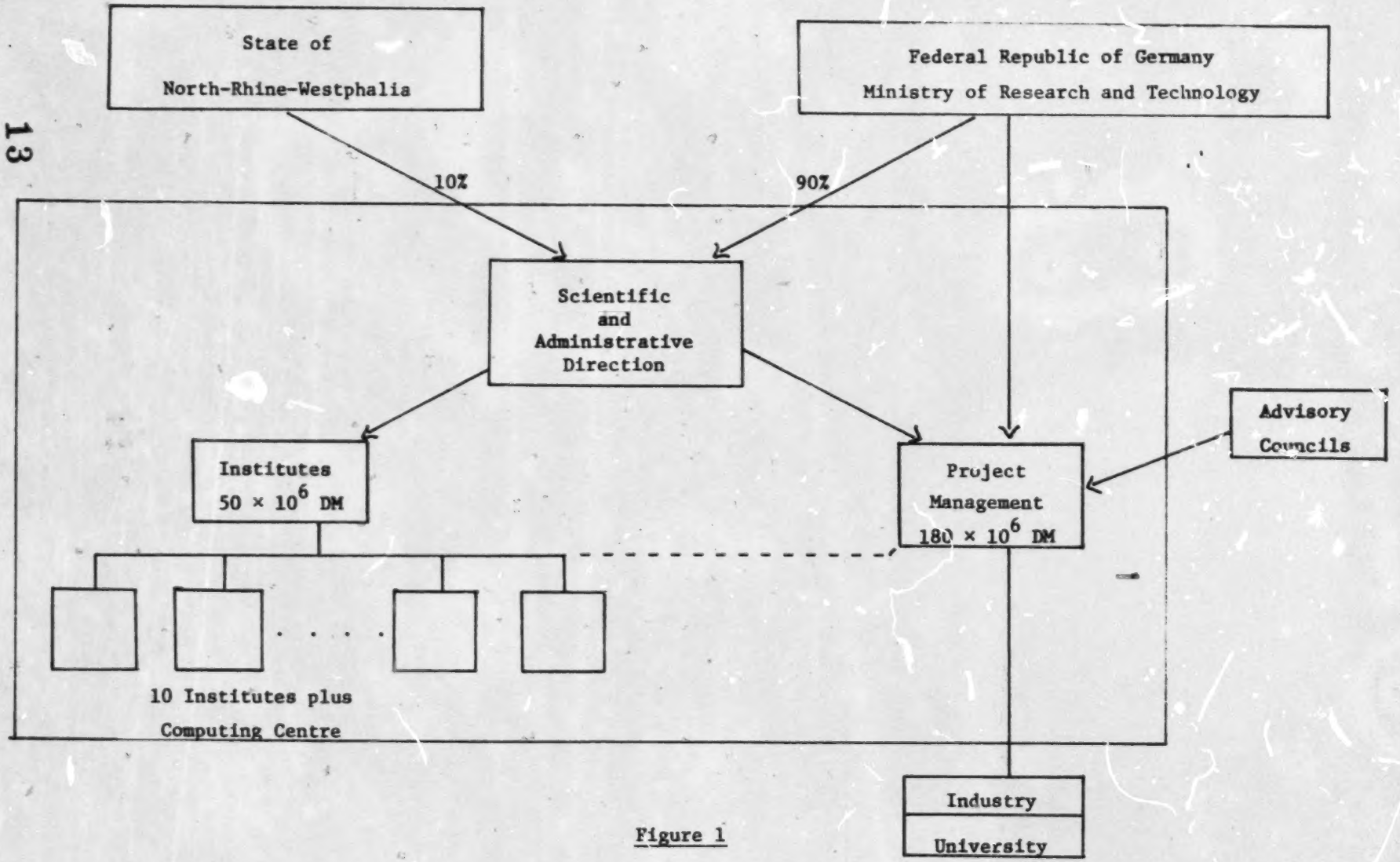


Figure 1

ORGANIZATIONAL STRUCTURE OF GMD

(Financial Figures are for 1974 Budget)

Within GMD, activities involving educational applications of the computer are the concern of the Institute for Education in Informatics. The institute operates as a college within GMD with two main objectives. These are to provide for the education of public service personnel in data processing and to carry out research and development related to computer education.

In its educational role, the institute provides courses in mathematics and computing. The structure of the data processing course is as follows:

- basic training ..... 4 weeks
- common special training ..... 11 weeks
  1. for Data Processing Managers
  2. for System Analysts
  3. for Programmers
- special courses ..... 1-3 weeks
  - data base management
  - statistics
  - teleprocessing
  - simulation
  - text manipulation

Instruction is given in small groups, with a lot of use being made of the computer and television. Twelve "group-rooms" are available, each with a capacity for 6 students and equipped with a computer terminal and a television monitor connected to a central TV studio in the school. Audio feedback from the student rooms to the TV studio is possible. The

instructor can lecture and assist students in specific group-rooms by direct communication from the studio. Throughout the process, the computer is used as the main tool of instruction.

An extensive instruction-oriented editing system has been developed which can be used effectively at three levels: beginner, normal programmer, and highly trained specialist. At the highest level, a sophisticated text processing language is incorporated in the editor comparable to SNOBOL. Extensive use is made of this facility in modelling applications.

Research activities of the institute are divided into three areas:

- improvement in use of the computer in education in general;
- development of model systems, including, for example, models of the computer for beginners, of operating systems, and economic models;
- curricular research.

Much attention is being given to the use of the computer in simulation and gaming activities. In these activities, the students act out a scenario and the computer is used to provide control, to route messages, to resolve disputes related to request conflicts, and to keep minutes. Protocols are developed to describe the activity and to provide a solution to the problem. An example illustrating the application of this technique is a study of the control of government vehicles in the Bonn area.

On the premise that most programming languages which are effective for practical applications are too complex for beginners, a "Student-Oriented Language" (SOL) is being developed to introduce students to computer programming. The target characteristics of the language are that

it be simple, consist of few elements and support modularity and structured programming. The language is "ALGOL influenced" and, while it has not yet been tested, the description given would indicate that it will provide a useful instructional tool for an introduction to programming.

Areas of Possible Cooperation

While direct exchange of CAL materials and programs would be limited by the language difference, exchange of information regarding techniques could be of considerable value. Specific activities at GMD which would seem to be of interest to Canadian institutions include the method of using the video display unit as an instructional tool, the techniques for developing protocols in simulation and gaming, the student-oriented language for introducing programming, and the methods used for introducing members of public service departments to computer utilization.

Forschungs und Entwicklungszentrum für Objektivierte Lehr - und Lernverfahren (FEoLL)

(Research and Development Centre for Substantiated Teaching and Learning Methods)

1. Organization

FEoLL, located at Paderborn, is a centre for research and development on methods of learning and teaching involving technology. Essentially, FEoLL carries out fundamental research on the techniques of programmed learning, teaching machines, computer-assisted learning and other media. Development is undertaken also of computer programs, models and hardware which can be used in teaching as well as in experiments as part of pilot projects and economic and sociological analyses related to the utilization of these media.

This Centre, founded in 1970, is financed and administered as a publicly-owned institute by the provincial government of North-Rhine-Westphalia. FEoLL employs approximately 100 research workers. For the most part, they are university professors engaged under contract for a period of five years. The annual budget is of the order of 2.8 million dollars and the management of FEoLL expects that the federal Ministry of Education will agree to pay 50% of this, beginning in 1975.

FEoLL consists of six institutes and three central project groups:

- Institute for Educational Computer Science;
- Institute for Educational Cybernetics;
- Institute for Educational Science;
- Institute for Scientific and Planning Theory;
- Institute for Educational Administration;
- Institute for Integrated Media Systems;
- Central Project Group for Media Teaching;
- Central Project Group for Media Sociology;
- Central Project Group for Data Processing in Education.

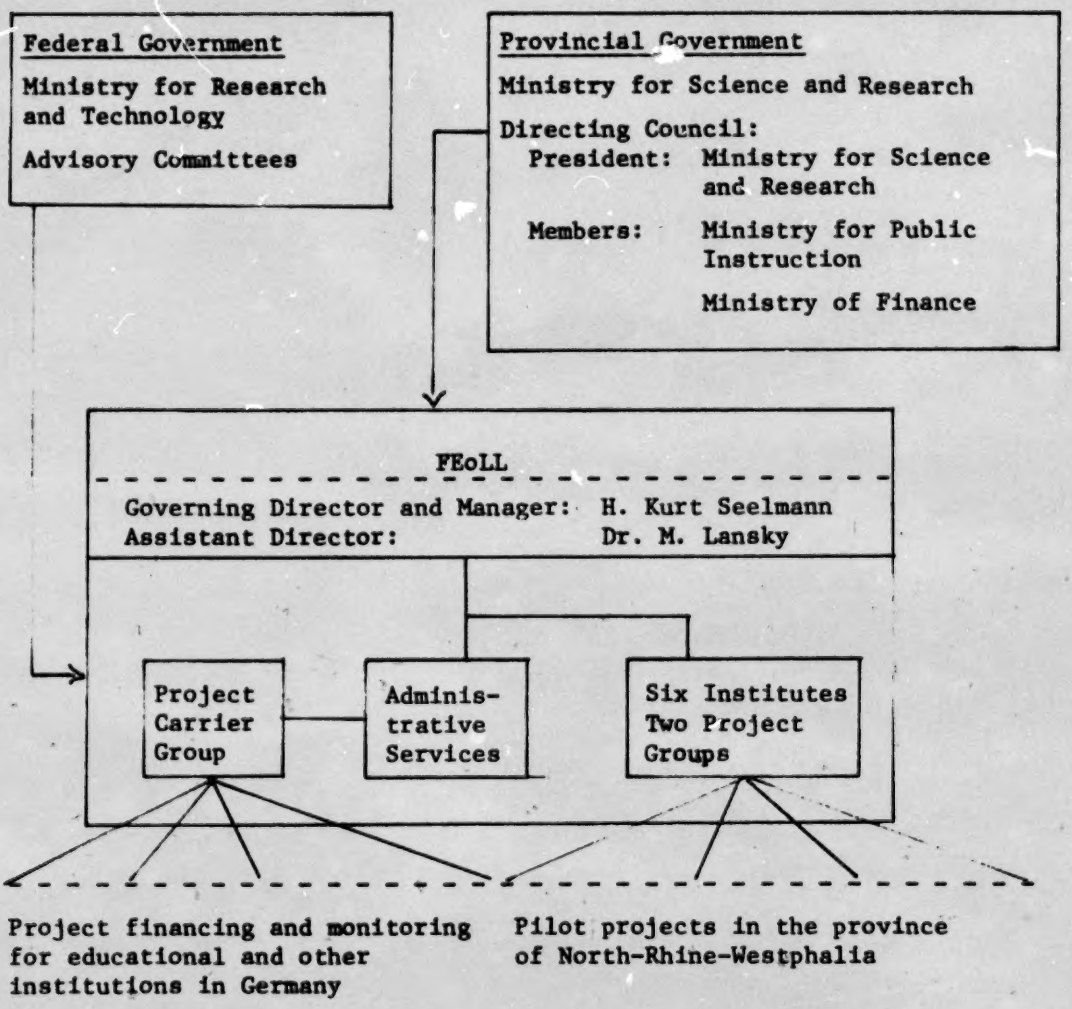
FEoLL was chosen in 1972 as the administrator or "project carrier" for the use of the computer in education within the framework of the Second Data Processing Support Program which is under the direction of the Federal Ministry for Research and Technology. The central project group of FeoLL for data processing in education has the following functions:

- review project proposals from educational organizations and other German institutions which deal with the use of the computer in education (both administratively and pedagogically);

- consult specialists or these projects (including other groups of FEoLL);
- present the projects along with recommendations for financing to the advisory committee of the Federal Ministry for Research and Technology;
- after approval, manage the financing of these projects and monitor technical progress;
- solicit and propose specific projects.

The project carrier group of FEoLL has a staff of five and handles an annual budget of approximately $6 million for about fifteen projects.

ORGANIZATIONAL STRUCTURE OF FEoLL


Federal Government
Ministry for Research and Technology
Advisory Committees
Provincial Government
Ministry for Science and Research
Directing Council:
President: Ministry for Science and Research
Members: Ministry for Public Instruction
Ministry of Finance
FEoLL
Governing Director and Manager: H. Kurt Seelmann
Assistant Director: Dr. M. Lansky
Project Carrier Group
Administrative Services
Six Institutes Two Project Groups
Project financing and monitoring for educational and other institutions in Germany
Pilot projects in the province of North-Rhine-Westphalia

2. Description

The limited duration of the visit to FEoLL restricted detailed study to the work of the Institute for Educational Computer Science, directed by Dr. Lansky. This Institute is composed of four departments:

- technical systems - Dr. Gensh
- mathematical structures and models - Dr. Tauber
- information processing - Mr. Kernell
- planning of experiments and evaluation - Dr. Krause

2.1 Technical Systems

As it is expected that next year, teaching of computer science will become a formal part of the secondary curriculum for students of 16 to 18 years in the province of North-Rhine-Westphalia, FEoLL is currently carrying out preparatory work to this end:

- development of small, low cost, analog computers for secondary schools. These computers:
  - permit connection to commercial colour television receivers to display curves and mathematical figures
  - permit connection to plotters
  - can include digital programming modules in order to simplify the programming and to extend their teaching possibilities
  - are compact, the smallest occupying approximately 14 square inches
- development of simple audio visual devices which can be controlled by computer, such as:
  - slide projector of which the principal element is a thin disc, approximately 10 inches in diameter, on which are placed approximately 60 small slides which can be selectively displayed by the computer. (A laboratory prototype was seen but this was not in operation)

. an interface for commercial audio cassettes capable of positioning 1000 audio messages on the basis of a sequential count. This equipment of simple technology and low cost is currently operational in the laboratory

- curriculum in information science: in anticipation of it becoming an official course, a secondary level curriculum in information science is currently being detailed
- teacher education: teaching machines (BASF model LG 3100) are being utilized in FEoLL in an experimental manner for the education of future teachers of information science.

2.2 Structures and Models

This department is currently developing the following computer programs:

CUUV (Computer-aided preparation of lessons)

This software is aimed at helping teachers in the preparation of courses by producing sequences for the teaching of concepts. Starting from information previously stored on the content of the course and a model giving the differential relationship between learning, unlearning and the forgetting of concepts, the computer presents questions to the teacher concerning the relations between the concepts in such a manner as to be able to produce a logical teaching sequence (incorporating revisions). This software is currently being tested at the comprehensive school in Garbsen.

ARD

This program extends the above software, CUUV. Beginning with a teaching strategy selected by the professor, the computer adapts logical teaching sequences to a pedagogical strategy in order to produce a complete course. This software is still in the developmental stage.

AVA

This computer-managed instruction program is for the education of future teachers of media. These teachers study at home using material furnished by FEoLL and can have certain exercises and work corrected by the computer through the program AVA. The evaluation and comments are returned by mail to the student.

CELP (Computer-aided structuring of curricula)

This software has the goal of prescribing the whole of a given course of studies at the university, starting from information specifying the pre-requisites for each course.

2.3 Other projects

The two other departments of the institute are carrying out several small experimental projects in the schools of the province on the application of computer science, specifically in two technical schools and also for disadvantaged students. These projects appeared to be at a very early stage.

3. Cooperation

The visit to FEoLL was of too short a duration to be able to specify in great detail the mechanisms and objectives of possible collaboration but some possibilities can be identified.

The work of FEoLL being often very theoretical, no specific exchange can be identified at the moment concerning CAL courses or of courseware in general. The curriculum for the teaching of computer science at the secondary level, however, might be the object of information exchange between Canadian provincial ministries of education and the government of North-Rhine-Westphalia.

The NRC and other Canadian centres interested in the development of technical apparatus for CAL or for the teaching of computer science could find some advantage in exchanging information on the computer-controlled audio visual equipment and on the analog computers for teaching.

Finally, exchanges of information and programs, mainly from Canada to Germany, could be considered in the area of computer networks for management and school administration through the project carrier group of FEoLL.

Project CLAB at the Integrated Comprehensive School at Garbsen

Organization

Project CLAB (acronym for "Computers Solve Problems of Education) at Garbsen is essentially a group of educational research workers and computer specialists working in close collaboration and on site with local teachers at the Garbsen primary school. The project is still young, having started in December 1972. The CLAB group is a part of the Ministry of Education of the State of Lower Saxony. The computing facility is a Siemens 4004/45 which has a capacity of 128 K bytes of core, 3 disks, 4 magnetic tapes, a card reader/punch and 30 display terminals located in

what is called the electronic classroom. Terminals cost about $6,000 and have a keyboard connected by a cable to the display which holds 20 lines of 54 characters. Total cost of the system is in the order of $32,000 per month.

The financial support from the Lower Saxonia Government for this project is somewhat higher (66%) than the support for the balance which comes from the Federal Ministry in Bonn (34%). The current phase ends in 1976 but indications are that funds will be forthcoming to allow the project to continue. In addition to maintaining the system, Siemens developed the software under contract from the Bonn Government.

Description

The project is concerned with the two main branches of informatics applied to education, namely with administrative problems and computer-assisted learning.

In regard to administrative applications, the CLAB group is attempting to establish a set of compatible programs which might be used in the nine computer centres in the state. These centres are supported by the counties and are thereby somewhat independent. Both Siemens and IBM computers are used. To solve the problem of machine independence, the work is done in the COBOL programming language but the acceptance of the administrative programs throughout the state can only be solved by mutual agreement.

The main tasks which have been completed to date are test surveys using mark-sense cards. It is hoped to have DIDAS, a new program for

school management, completed by 1 February 1975. The specific projects are complemented by a broader program in which it is attempted to see the educational system in an integrated manner. Here the main difficulties are anticipated as problems of coordination, which the group is attempting to solve with the aid of a coordinating body. Project CLAB also has the ubiquitous problem of trying to integrate the computer into the classroom. At present there is the tendency to think of the computer as an adjunct rather than to attempt a full integration.

In CAL the work is primarily remedial. The language is LIDIA, a Coursewriter type language for the Siemens machine written in assembly language. The programs (about 40 in all) are concerned with obtaining smallest common factor and prime number, game playing and drills, certain exercises in physics and chemistry and problems of learning English. The game playing problems simulate the actual game.

Teachers at other schools teach 24 hours per week but at Garbsen it is usually 20 hours. Teachers who write CAL lessons have 6 to 9 hours further reduction. The computer lessons are in use mainly in the sciences.

One of the reasons for the emphasis in CAL at Garbsen is that it is considered to be a possible aid to make up for the shortage of teachers. The school is large, with some 1700 pupils divided into about 60 classes of 30 students each. These are highly active children in a dynamic middle class environment with all of the associated difficulties and advantages which go with large size and surplus energy. The group considered itself very definitely as experimental. The participating teachers hope that through new teaching aids such as CAL, they may be able to help solve at least some of their problems.

Areas of Possible Collaboration

One of the more definite prospects is in the teaching of English as a second language. This was discussed since there also exist similar projects in Canada. The experiment at Garbsen, in making a definite attack on the problems of cost effectiveness, will be of interest to most Canadian groups. The close interaction with teachers puts this group in the position of having a rather special on-site experience. Also, the administrative model offers possibilities of exchange in the administration field. The projects are well documented which makes them easy, barring the language problem to use in Canada.

Insofar as collaboration re CAL materials is concerned, direct exchange is not feasible unless there is translation for both machine and natural language. The technical environments are different but not insuperably so. It should not be too difficult to make programs available in LIDIA accessible in other similar CAL languages. How extensively this should be done is another matter; it seems to be worth looking into on the scale of a small pilot study. A closely related problem is that LIDIA is used on the Siemens terminal which has the relatively small screen comprising 20 lines of 54 characters each. Thus, the rhythm of the program is different and purely automatic translations from a program in LIDIA to one in (say) ETL may not be advisable.

Research Centre for Rehabilitation, Prevention and Vocational Training
Part of the Stiftung Rehabilitation, Heidelberg, Germany.

The Stiftung Rehabilitation is the largest institution in Germany concerned with the vocational settlement and social integration of the handicapped into the community. It comprises rehabilitation centres,

also residences and a hospital, and research institutes concerned with various aspects of rehabilitation.

Research and development of computer-assisted learning has been underway for some five years. It is aimed at providing facilities for the basic education and vocational training of the handicapped and is undertaken at several locations:

1. The Berufsförderungswerk is a vocational retraining centre for 1700 adults, located at Heidelberg. It admits handicapped persons, some confined to wheelchairs, between the ages of 18 to 59 years, and provides accommodation up to 3 years. Vocational training is offered in 50 different occupations, ranging from apprenticeships to professional qualifications. Training programs cover business administration, tool making, machine building, electrical and electronic engineering, data processing, building trades, health service occupations, architecture, etc. For some professions, including engineering technologist, the examinations may be taken at the Stiftung.

Within this organization, the Research Centre for Rehabilitation, Prevention and Vocational Training employs 100 research workers on the development of new concepts and modules for teaching and learning. It has five research groups, of which two, dealing with informatics and education respectively, work together in the development of CAL.

2. The Rehabilitation Hospital near Karlsruhe, 60 kilometers from Heidelberg, has 30 beds and is being expanded to 625 beds. Terminals linked by phone line to Heidelberg will be used for vocational training, also information retrieval and documentation.

3. A Residential Comprehensive School for handicapped children at Neckargemünd, 15 kilometers from Heidelberg, opened in September 1974. This includes a kindergarten, a primary and secondary school, and a vocational training centre for school graduates. It presently has 400 places and will expand to 1000 places. Students have multiple handicaps (motor, locomotion, learning, speech) with associated secondary disabilities (weak motivation, poor communication, social maladjustment, etc.). It is planned that computer terminals for CAL will play a central role in the education provided by this school.

4. A Central Institute for Vocational Counseling, with 200 residential places, was established in 1973.

5. An Academy for Specialists in Rehabilitation is in the planning stages.

Research efforts are directed towards the development of self-instructional multi-media systems to assist the development of the dormant intellectual capacities of the trainees. CAL is envisaged as an integral part of such systems. The computer is used essentially as an adaptive teaching machine to provide individualised training programs and replace conventional classroom instruction. It is part of an instructional system in which the teacher is relieved of routine work so that he has more time available for student guidance.

Notionally, TV is used to motivate and to provide information; computer programs are used to give practice; and teachers conduct tutorials. However, it should be remarked that computer programs which were seen in

operation provided more than simple drill and practice: they included answer processing routines which could branch the student into remedial lessons incorporating instruction to assist him in overcoming his difficulties.

Several hundred CAL programs have been developed by about 70 different authors and have been coded by expert programmers. Currently they serve more than 2000 students. In the Berufsförderungswerk, lesson periods are from 8:00 a.m. to 5:00 p.m. and terminals are used on a voluntary basis in the evenings until 9:00 p.m.

The subject areas covered by the CAL programs include mathematics, economics, finance, engineering, computing, etc. A loose-leaf folder alongside each terminal gives instructions for using the computer, together with a complete listing of programs and a call number and brief description of each.

Approximately 70% of the programs are of the drill type, with some tutorial elements and remedial branching. However, attempts are now being made to develop more simulations and games. These include, for example, simulations of economic systems, of the stock market, etc. Programs currently in use are mainly instructor-controlled but more student-controlled programs are now being writtten. Records are maintained of all student responses, primarily in order to enable authors to improve their programs.

In the Berufsförderungswerk, where 30 terminals are in one room, one proctor is on duty to assist students in using the terminals and obtaining programs.

Two computer systems are presently used in this project:

1. A Siemens 4004/151 computer, with one drum, five disks and four magnetic tapes. This machine supports, locally, 33 Siemens video display terminals which are hardwired; 7 hardwired Tektronics video display terminals; and 4 teletypes. There are also attached to the machine at the present time, or projected for the end of 1974, another 57 terminals to be located remotely at 9 different centres. Of these, 30 will be in the school at Nechargemünd; others will be as far away as Bremen, Paderborn, Freiburg and Munich. The principal language used on the machine is APL.
2. An IBM 370/155, with 2048 K bytes of core memory, 18 disks, 4 magnetic tapes, and other peripherals. Attached to this machine, or to be attached by the end of 1974, are 40 IBM video display terminals. Additionally, further 2740/2741 hardcopy terminals are to be attached remotely at 6 locations, including Hamburg, Essen, Frankfurt and Linz (Austria). The total number of terminals by the end of 1974 will be 250, and by mid-1975 it will be 267. The principal language used on the computer is APL.

When the project was initiated in 1969, with an IBM 360/50 computer, the language used was Coursewriter. APL was first used in 1970 and PLANIT in 1972. When the authors have been free to choose their language, they have used APL. This language gives far better response time than PLANIT or Coursewriter and includes a compute mode. It is anticipated that, for the immediate future, all courseware will be implemented in APL.

Projections for the further development of the present facilities include the provision, by 1976, of DEC 11/45 computers at 10 remote centres. It is intended that these will be used as local machines, with backup from the central computer in Heidelberg. Primarily they will be used for CAL but could also be used for administrative work during the night.

The present Siemens machine is dedicated to CAL. The IBM 370/155 is used almost entirely for CAL but approximately 10% of its capacity is used for administrative work at night.

Possibilities for Cooperation

Possible areas of cooperation with this project relate to computer languages, plans for the organization of instruction which include CAL, terminal equipment and a network organization.

At the present time, the project uses the language APL. This language is also being used in several Canadian centres and there are possibilities for the exchange of programs and information.

However, although the Heidelberg project is presently committed to the use of APL, there is no certainty that this commitment will be carried into the indefinite future. Officials in Bonn indicated that the decision to use APL had been made on strictly pragmatic grounds. There is, therefore, a possibility that the Heidelberg project could be interested in the NRC language at a future date.

Programs and procedures related to CAI for the handicapped, and ways of introducing CAL into curricula for the handicapped, could probably form a basis for cooperation between the Heidelberg project and

the University of Calgary. Both have a commitment to develop CAL for this type of population, although the emphasis at Calgary is more heavily upon the retarded.

The Heidelberg, project is potentially interested in special purpose terminal equipment, such as that currently being developed at NRC, and could probably benefit substantially from the NRC work. At both centres, networks are being developed for CAL and it appears there will inevitably be problems of common interest in this regard.

University of Freiburg

The CAL facility at the University of Freiburg is dedicated to the development of instruction in mathematics and biology. It has been active for four years and is funded by the federal government to operate into 1975, after which time it is expected that the province (Breisgan) will continue funding the project.

Current project staff include the following personnel:

- Dr. Gotwald, Project Director;
- J. Ewen, Engineer;
- H.J. Hanke, Ph.D. in Biology, with school teaching experience;
- P. Ripota, Engineering Physics degree, interest in language and documentation;
- P. Schabolowski, a Biologist with teaching experience;
- W. Geist, previous student at Freiburg; teaching certificate, tutor.

The above project staff are full-time to the project and sufficient funds are available to employ seven more. All salaries are paid by the federal government project funds for CAL (CUU).

Professor Heffner started the CAL project in the area of genetics because computer simulated experiments were easily integrated into the subject matter. CAL material now includes simulations as well as some tutorial lessons. A catalog of programs is available from the facility. Consideration is being given to some integration of courses between the university and local high schools in the areas of French, German and biology.

Currently, the computing equipment consists of a Siemens 4004/151, which replaced a smaller Siemens 4004/45 in March 1974. Fifteen terminals are located locally, two are located in a mathematics building, while two are located at a teacher training institution. Terminals are of a Siemens type employing a complete typewriter-like carriage system which moves across the page. One such terminal on site was modified for the use of the APL character fonts. It appeared that the terminal was capable of about 20 cps. No video display terminals, such as those found in Hannover, Bonn, Heidelberg, and Augsburg were in use. The printing terminal was stated as costing about 15,000 DM. Two microfiche readers for viewing of pictures were available for use beside terminals. The microfiche readers were manually positioned by the students as directed by the CAL program.

This project spent some time getting PLANIT operational on their facility. In addition to the PLANIT language, BASIC, APL and FORTRAN were also available.

The Siemens 4004/151 being used entirely for CAL has the following hardware characteristics:

1. 393 K core (plans to go to 512 K core)
2. 4 million character drum storage
3. 8 million character virtual memory system
4. 55 million character disk system (4 disks accessed in two pairs)

The system rents at 100,000 DM including terminals, or about $40,000 per month in Canadian Dollars. It was reported that the hardware was very reliable with fewer than four failures per month. The hours of operation are from 8:00 a.m. to 7:00 p.m., with other times not being used because of the extra rental charges which would be incurred to Siemens. (This appeared to be the case at other installations also.) A video display unit at the operator's console noted sign-on and sign-off activity of the terminals but there did not appear to be the necessary software to interrogate the contents of the disk files. Performance records of students as defined by PLANIT are stored on disk and copied once per week to magnetic tape.

Problems voiced by project staff indicated some difficulty in communication between project members and academic staff members of the university. Project staff members do not hold academic appointments to the university. Problems were cited which are common to many CAL projects. For example, there is the problem of assuring adequate communication between project staff and university faculty regarding what topics should be taught and how they should be taught. It was noted that a report outlining some of the problems of bringing CAL into the university environment was available.

CUU - Projekt Augsburg (CAL - Augsburg Project)

Project Organization

The project at the Ste. Anna Gymnasium in Augsburg, Bavaria, is claimed to be the first attempt in continental Europe to integrate CAL into a school curriculum. The school has 1100 students ranging from 10 to 19 years of age with CAL being used at all levels. The project started in late 1970 with two leased lines to an installation in Munich. In 1972, a Siemens 4004/45 computer with 17 terminals was installed. Currently, there are 30 terminals composed of 29 video display units and one printing terminal with six located remotely (five in Augsburg and one about 35 kilometers south in Lansburg).

The project is federally funded until the end of 1975 when the Bavarian State should begin to support the centre. The outlook among the staff was optimistic, with plans being made for a larger machine with more language processors.

Dr. Keil is the project leader and has structured the staff into three groups. One group is composed of three data processing specialists with one keypunch operator, one systems programmer, two instructional programmers and two machine operators supporting the operations. One psychologist forms the other team and a curriculum group is composed of a variable number of teachers working on courseware. The teachers have course writing commitments which vary from teacher to teacher. Usually a teacher works on course authoring from two periods per day to full time. Also, some work is done on a contract basis. Some courses are being produced by teams and some by a single instructor. Courseware is

coded on forms, keypunched and batch loaded to a pre-processor which produces an intermediate language used by the LIDIA interpreter.

Description of Work

Mathematics: At the sixth grade level, there are five class groups operating with five integration models. No evaluation results have been obtained yet from this study. The integration of CAL is done on the entire four-day class week. The programs cover number theory, addition and substraction of fractions, factoring, etc., and a number of instructional strategies are employed, including discovery learning. One group uses 20 to 25 minutes of CAL then the rest of the period is used in group work, while the comparison group takes group work, then CAL. Another group attends three group sessions, followed by one complete period with CAL. Another group has the teacher trying to integrate CAL in a voluntary way at the end of the regular class.

At the seventh grade, students have CAL algebra for two hours per week and two hours of geometry by conventional instruction.

At the tenth grade level, a number of trigonometry programs are available. The strategy is being changed from program to learner-controlled.

Physics - Several introductory and simulation programs are available.

Chemistry - Work in this area appeared to be centered on the analysis of materials.

Biology - There are several analytic programs for biology dealing with peptides and amino acids.

English - A set of short programs exist for teaching aspects of grammar (e.g. negation, interrogation and tense) to students aged 13 to 14 years old. Students at the Gymnasium normally take Latin, then English, then French or Greek. One student has written programs to generate drills in Latin and German irregular verbs.

Evaluation - The staff psychologist, Dr. Karl, is mainly concerned with measurement of attitudes. He plans to use university students to develop questionnaires for student and teacher use. The only results reported were a general liking for CAL by students but the enthusiasm for CAL decreased as the age of the student increased.

Systems - The systems group is mainly concerned with data collection for feedback to teachers and course authors. Since the LIDIA system is vendor supplied, it does not appear that users may alter the software.

Possible Cooperation

Several areas of possible cooperation between Canadian centres and the Augsburg project should be explored.

Papers concerning formative and summative evaluation techniques, the types of data to be collected and the data analysis techniques to be employed should be exchanged.

A definite interest was expressed in the technique for dissemination and diffusion and organizational structures to facilitate these goals. The major factors in this area are cultural, social, political and economic; therefore, there may be only academic interest in exchanges in this class of paper.

Courseware exchange seems possible. Coursewriter and CAN appear to be the closest languages to LIDIA. From the Canadian viewpoint, a difficulty would seem to arise in using courseware written in German. It is possible, however, that Canadian courseware could be used to advantage in Germany because of the English language requirement in German schools.

Research in learner and program-controlled CAL is of interest to both German and Canadian groups. It appeared from the discussions that both countries are moving towards the production of learner-controlled courseware, although there is little empirical data to justify this approach.

Summary

Through the Data Processing Support Program of the German Government, major support is being provided for research and development projects in computer-aided learning. The program appears to have achieved effective collaboration between federal and state governments and could be closely examined in relation to Canadian support for research and development in CAL because of the similar division of responsibilities in the two countries insofar as scientific research and education are concerned.

Several areas of possible cooperation were identified during the visit but any cooperative activity in these areas would be primarily concerned with the exchange of information in the form of papers, computer programs and possibly guest workers. It was felt that at this time it is

not possible to define a project to be undertaken jointly. Specific areas in which an exchange of information would be of benefit are CAL techniques for medical instruction and for instruction of the handicapped, problems associated with the introduction of CAL into existing systems, evaluation and data analysis techniques, general system techniques including information on terminal hardware and programming languages for CAL. While some exchange of courseware might take place, this would be limited by the language difference.

Some difficulties in the exchange of information arise from the difference in language. Few Canadians in the CAL field have a working knowledge of German. Since most of the German CAL workers have an effective command of English, a common language exists for exchange between Canada and Germany. However, very little of the German CAL work is published in English or French, most of it being published in German. It is suggested that the exchange of information between centres in the two countries could be greatly facilitated if there were available in Canada a central facility for the translation and dissemination of German CAL literature.

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